Message

From: Landes - CDPHE, Scott [scott.landes@state.co.us]
Sent: 3/16/2018 4:41:05 PM
To: Payton, Richard [Payton.Richard@epa.gov]
Subject: Re: Could you help us with IPV/PT/RH plots for our draft SI EE Guidance Document

Total column ozone is on a 2D grid, hence you are unable to see ozone concentrations at individual levels -- just the total column.

Ozone mixing ratio is available on a 3D grid. However the lowest layer that it displays is 400 mb which is probably not very useful in trying to identify an intrusion.

--Scott

On Fri, Mar 16, 2018 at 8:15 AM, Payton, Richard <Payton.Richard@epa.gov> wrote:

> Could GFS ozone be used to visualize the intrusion? That is, does it do 3-D ozone simulation, or only something cruder that yields total column, but not actual concentration in 3-D?
>
> Richard
>
> **From:** Landes - CDPHE, Scott [mailto:scott.landes@state.co.us]
> **Sent:** Thursday, March 15, 2018 5:06 PM
> **To:** Payton, Richard <Payton.Richard@epa.gov>
> **Cc:** Gordon Pierce <gordon.pierce@state.co.us>; Dolwick, Pat <Dolwick.Pat@epa.gov>; Tonnesen, Gail <Tonnesen.Gail@epa.gov>; Dan Welsh - CDPHE <dan.welsh@state.co.us>; Amber Ortega - CDPHE <amber.ortega@state.co.us>
> **Subject:** Re: Could you help us with IPV/PT/RH plots for our draft SI EE Guidance Document
>
> Hi Richard,
>
> To start, we utilize Integrated Data Viewer to ingest, process and display atmospheric model data for our stratospheric intrusion forecasting and analysis. IDV is available as a free download. Below is a description of IDV from the Unidata website (https://www.unidata.ucar.edu/software/idv/):
>
> The Integrated Data Viewer (IDV) is a framework for visualizing and analyzing geoscience data. The IDV release includes a Java™-based software library, and applications made from that software. It uses the VisAD library for data and display models as well as other Java utility packages. It was developed at the Unidata Program Center (UPC), part of the University Corporation for Atmospheric

Research, Boulder, Colorado, which is funded by the National Science Foundation. The software is freely available under the terms of the GNU Lesser General Public License.

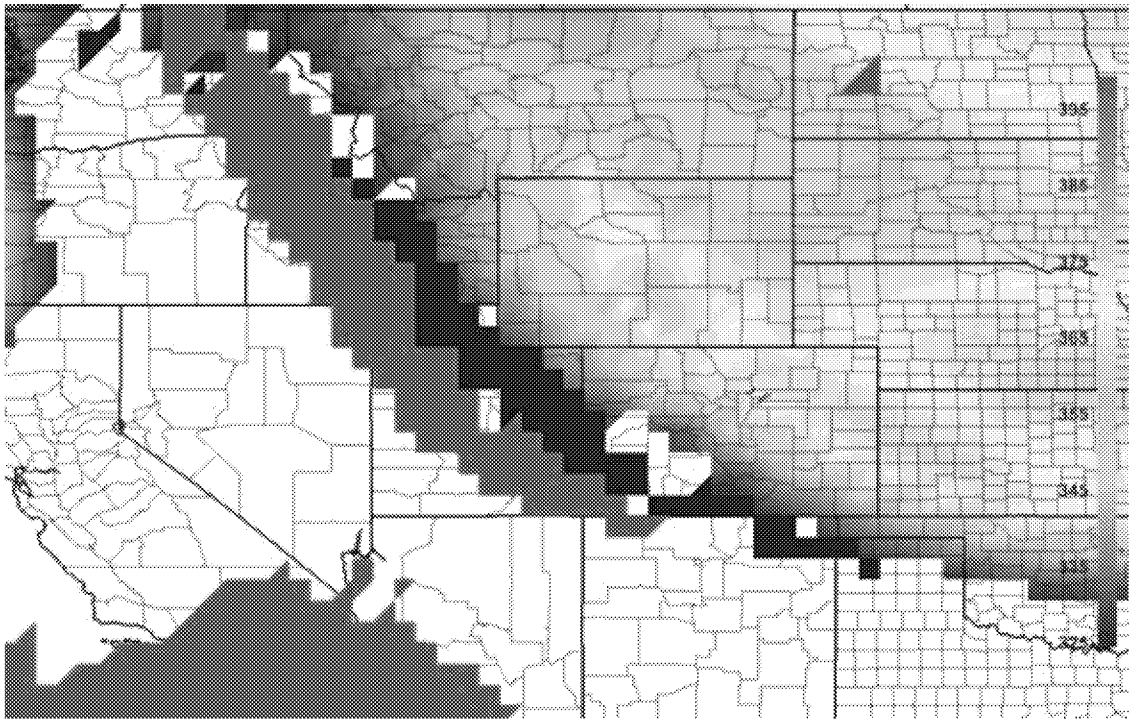
The IDV brings together the ability to display and work with satellite imagery, gridded data (primarily from model output), and surface, upper air, and radar data within a unified interface. The IDV "reference application" provides many of the standard 2-D data displays that other Unidata packages (e.g. GEMPAK and McIDAS) provide. It also provides 3-D views of the atmosphere and allows users to interactively slice, dice, and probe the data to create cross-sections, profiles, animations and value read-outs of multi-dimensional data sets. Computation and display of built-in and user-supplied formula-based derived quantities is supported as well. It includes an integrated HTML interface that can be used to create HTML based users interfaces to drive the displays, or to embed IDV displays and controls directly in an HTML document.

In IDV we create "bundles" where we store meteorological data, atmospheric model output, maps, etc. This makes it easy for us to quickly load one of these bundles related to the atmospheric scenario we want to evaluate. For example, we have a stratospheric intrusion bundle that includes the variables:

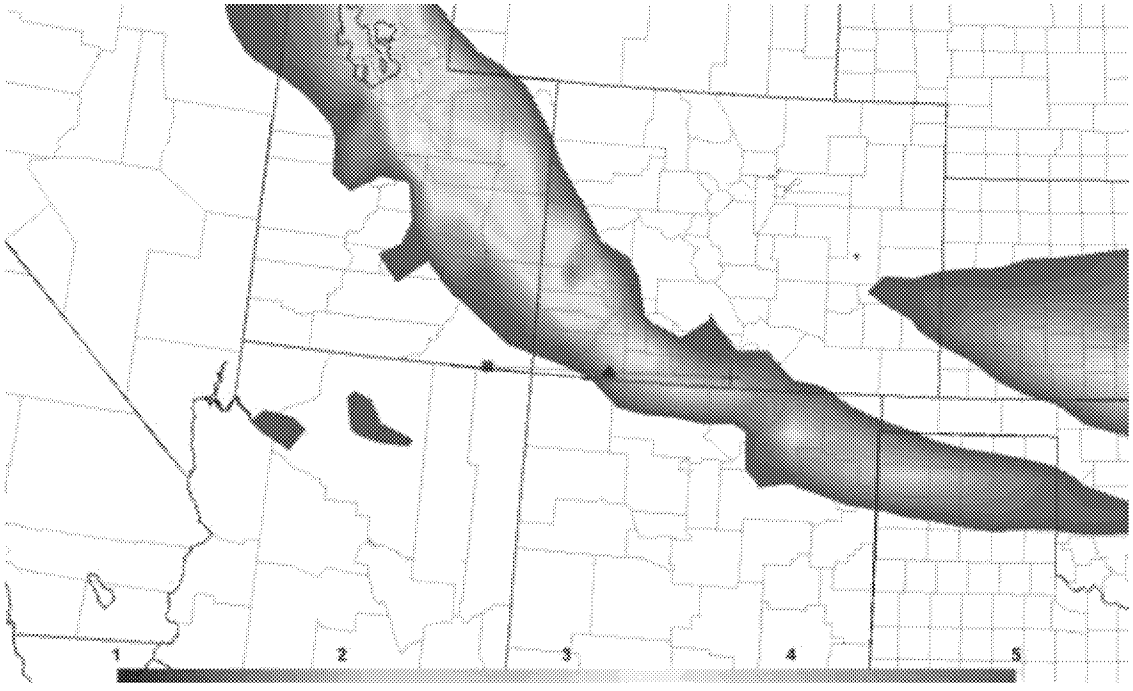
600 mb RH
600 mb IPV
Total Column Ozone

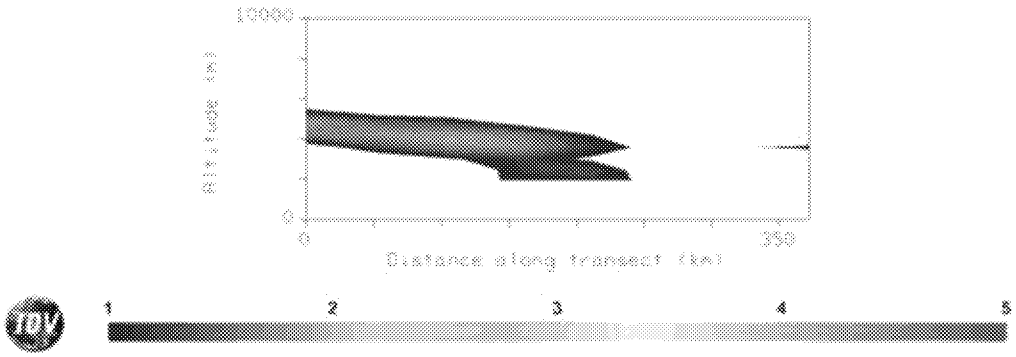
These individual variables can be loaded with model re-analysis data (helpful in flagging exceptional events and in the development of a demonstration), or model forecast data (good for operational/advisory purposes). Our intrusion bundle utilizes the GFS 0.5 Degree model output. We mainly utilize the GFS because I have been unable to find another model in IDV which will model Total Column Ozone. Although we don't include potential temperature in our intrusion bundle, it is available and can be easily added if so desired.

Below is the GFS 0.5 degree reanalysis from 12Z April 22 2017. The display consists of Total Column Ozone $\geq$ 325 ppb, 600 mb Relative Humidity of $\leq$ 10%, and Isentropic Potential Vorticity $\geq$ 1 PVU ($m^2s^{-1}kg^{-1}K$). We normally look for the convergence of these three variables as a potential area of concern for stratospheric influence. As you can see below, April 22 2017 was a textbook case for the Four Corners region.



Below is an alternate view of the GFS 0.5 degree reanalysis of IPV at 12Z April 22 2017, with the associated cross-sectional analysis. You can see in the cross-section the elevated IPV at low altitudes, particularly the lobe near the center of the transect which is located directly over the Southern Ute Reservation and essentially at the earth's surface (≈ 2000m elevation)





I tried, but failed miserably, to replicate Pat's Figure 19 with IPV along a potential temperature surface. There is a way to do it in IDV though I have yet to completely figure it out. If I have a breakthrough I'll definitely let you know.

If there is anything else I can help out with please let me know.

Best,

--Scott

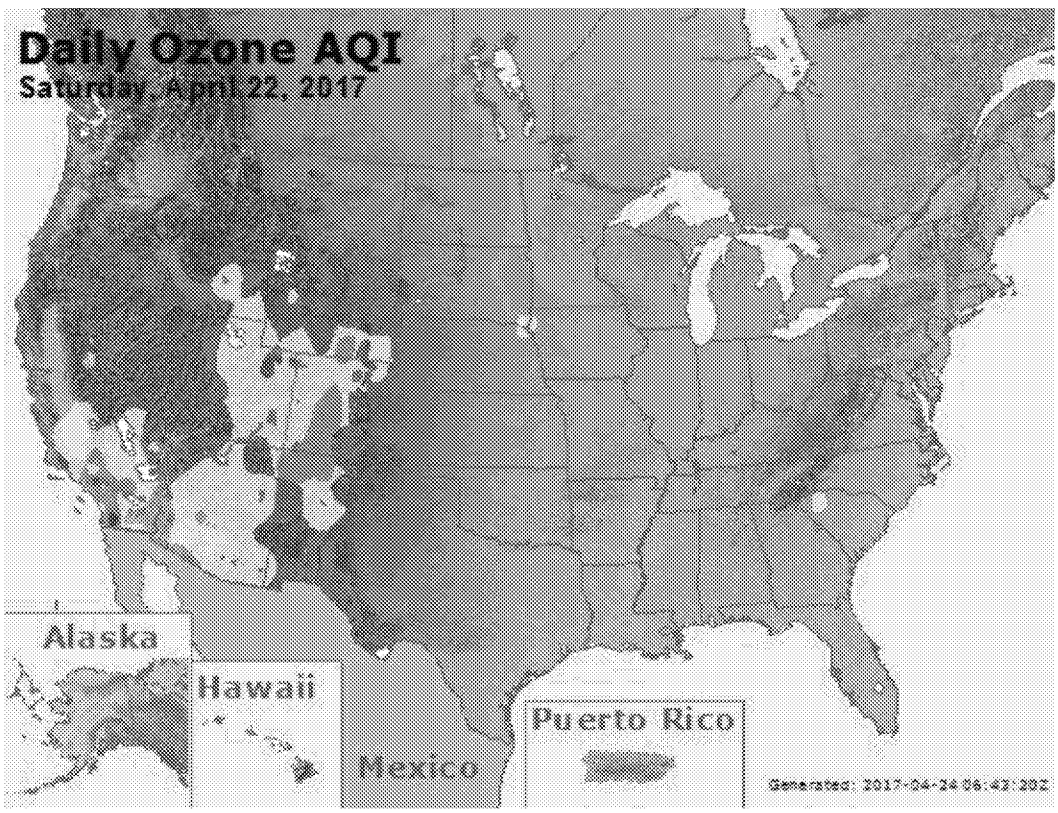
On Wed, Mar 14, 2018 at 8:09 AM, Payton, Richard <Payton.Richard@epa.gov> wrote:

Scott:

We have been working on a draft of guidance for the development of Stratospheric Ozone exceptional event demonstrations. We will be sharing the draft with the SI workgroup in the near future.

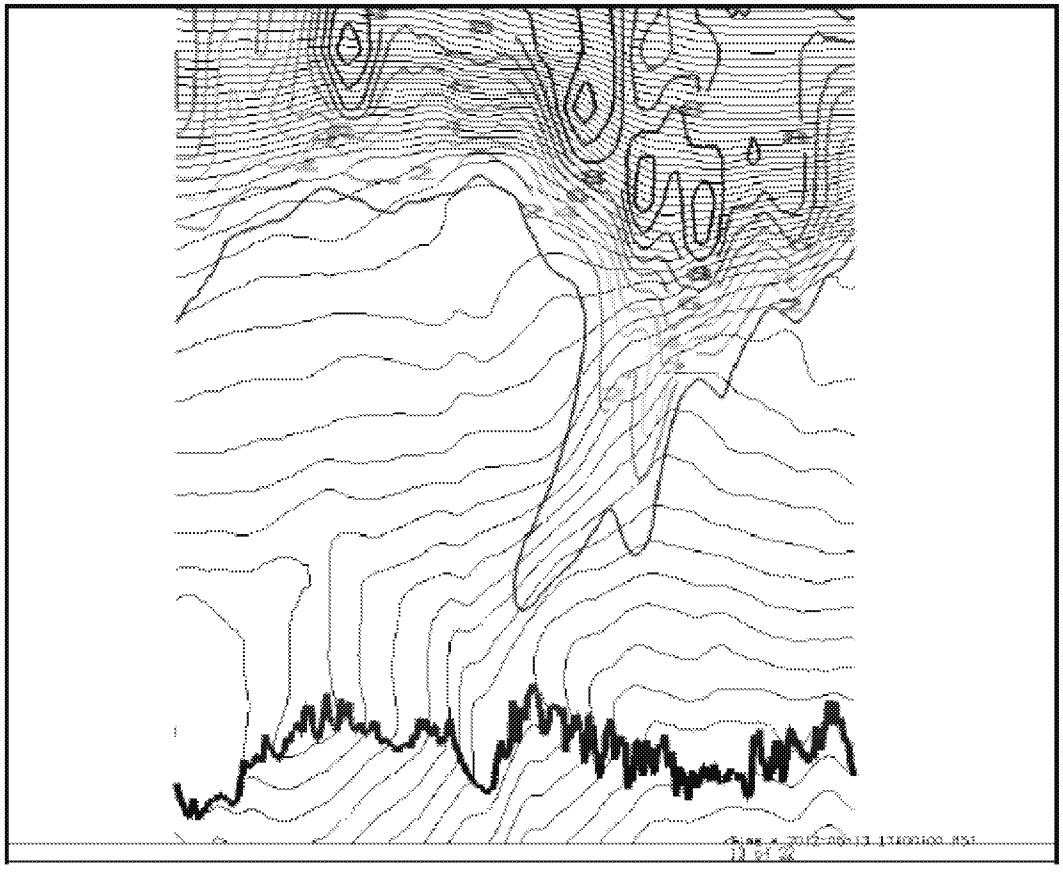
Throughout, we are using the 4-Corners SI event of April 22, 2017 as our example. We have graphics from many readily available data sources in the guidance, but at present do not have graphics of model based IPV/PT, which I have found to be one of the most compelling pieces of data in previous demos from CDPHE and Wyoming. I am wondering if you could help and generate a plot or two that we could include in the guidance.

Ozone on April 22, 2017 is shown in Airnow as:



Plots I found useful in the past include this from the Wyoming June 2015 demo, where Ryan managed to include IPV, RH, terrain and PT all on one chart:

Figure 21. RAP 20-km, 0-hour analysis showing south-to-north cross-section (left-to-right) terrain (solid dark line), IPV (colored contours starting at 1-PVU), RH (shaded areas depicting RH values less than 15%), and PT (thin black contours) cross-section valid at 5 pm MST, June 13, 2012. Click image to enlarge. Data below terrain not real.



this one from your 2010 demo where (I presume) Pat included surface pressure, IPV and mixing height on one chart:

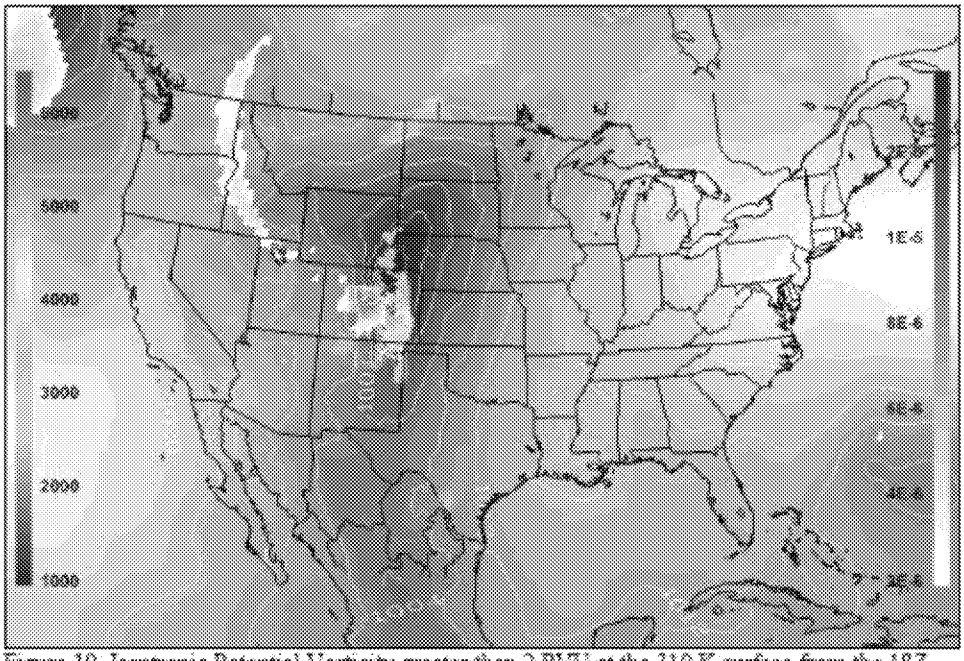


Figure 19. Isentropic Potential Vorticity greater than 2 PVU at the 310 K surface from the 18Z run of GDAS 0.5 degree by 0.5 degree model for 12:00 MST May 24, 2010, shaded in blue (right scale in native IPV units of $^{\circ}K\,kg^{-1}\,m^{2}\,s^{-1}$); mean sea level surface pressure in mb (white contour lines and gray shading); and planetary boundary layer height or depth of mixed layer above the ground in meters for values greater than 3000 meters (rainbow color gradients and left scale) at 11:00 MST on May 24, 2010, from the 18Z initial analysis of the 18Z NAM12 model.

On the other hand, simple IPV along a transect, also from your 2010 demo is pretty good too:

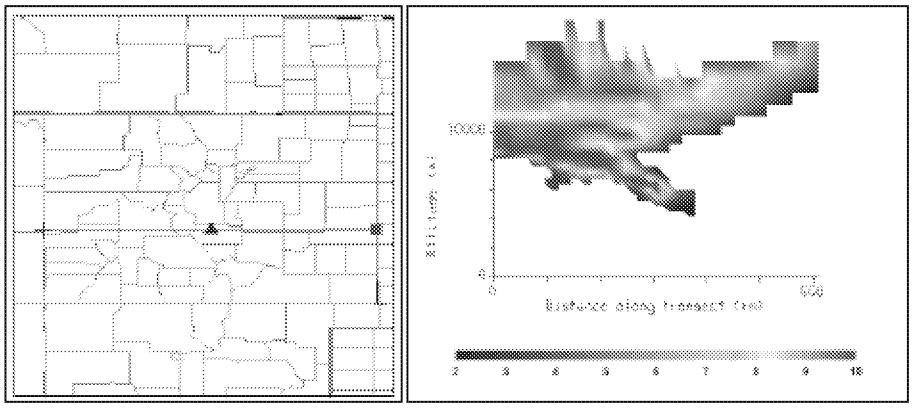


Figure 14. Vertical cross-section of IPV in the atmosphere in central Colorado (location shown in left panel) in PVU values of 2 or greater as a function of altitude above sea level in meters - based on the initial analysis data from the 18Z run of the NOAA/NCEP 12-kilometer grid NAM12 on May 24, 2010.

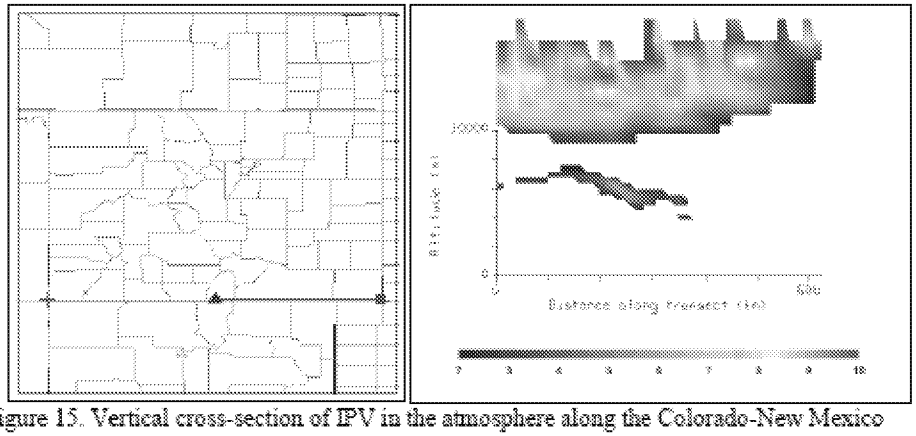


Figure 15. Vertical cross-section of IPV in the atmosphere along the Colorado-New Mexico border (location shown in left panel) in PVU values of 2 or greater as a function of altitude above sea level in meters - based on the initial analysis data from the 18Z run of the NOAA/NCEP 12-kilometer grid NAM12 on May 24, 2010.

Please let me know if Gordon will let you devote a few hours to this; if you can, we would like to have a synopsis of the steps you used (where you get the modeled data from, what its native format is, how you process/interpret the data, what graphic tool you use, some idea of how the tool goes from (I presume) binary data to graphic/mapped pictures).

Thanks for any help you can provide.

Richard

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"Are you curious about ground-level ozone in Colorado? Visit our ozone webpage to learn more."

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